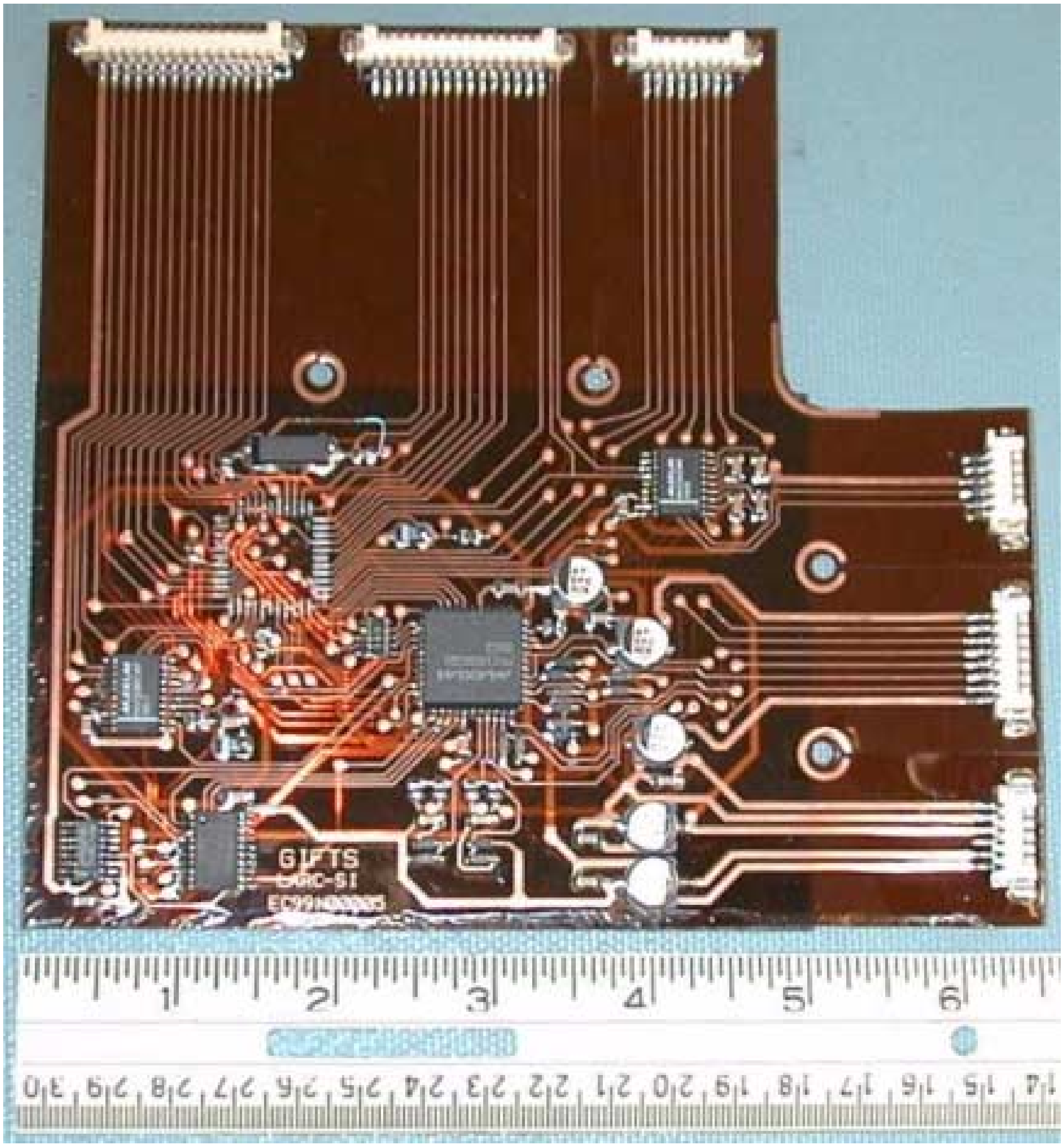
# GIFTS Multi-layer Flex Circuit Evaluation




Project Name/Date (month/year): Geostationary Imaging Fourier Transform Spectrometer “GIFTS” Multilayer Flex Circuit. June 1999

What is in the photo? A multilayer (3 layers) polyimide flex circuit fabricated with a NASA Langley developed plastic known as Langley Research Center - Soluble Imide or "LaRC-SI". Each layer of polyimide film is 2 mils thick with a 1 oz. (1.4 mils) copper pattern. The three individually patterned layers were "thermal-compression" bonded using an autoclave. The films were processed in the autoclave at 300 C, 100 PSI, for 1 Hour, and formed a monolithic circuit. One of the key advantages of using LaRC-SI is that multi-layer flex circuits and cables can be formed without the use of adhesives. Because the LaRC-SI material fuses together with heat and pressure, there is no need for a glue or adhesive to bond the individual layers together. The adhesive is often the most problematic material in a multi-layer flex circuit stack; therefore, eliminating it altogether offers numerous advantages. Some of the advantages include: better matched Coefficient of thermal expansion, thinner more flexible circuits, lighter end-weight, and a reduction in materials and processing costs.

## GIFTS ABSTRACT

The Geostationary Imaging Fourier Transform Spectrometer (GIFTS) is a measurement concept which combines a number of advanced technologies, including particularly the Large area format Focal Plane detector Array (LFPA) with the Fourier Transform Spectrometer (FTS). The GIFTS will improve the observation of all three basic atmospheric state variables (temperature, moisture, and wind velocity) allowing much higher spatial, vertical, and temporal resolutions than is now achievable with currently operational geostationary weather satellites. The displacement of the measured water vapor and cloud features will be used as tracers of the transport of atmospheric water as well as other important constituents (e.g., CO and O3). A key advance over current geostationary wind measurement capabilities is that the water-vapor winds will be altitude-resolved throughout the troposphere. Thus, GIFTS observations will lead to a significantly better understanding of weather and climate processes, including the atmosphere’s water cycle and the transport of greenhouse and pollutant gases.

Because of limited fields of view, residence time limitations, and footprint movement, this significant improvement in measurement capacity cannot be fully demonstrated from aircraft or LEO. However, theEO-3 mission can conclusively prove the GIFTS breakthrough measurement concept for altitude-resolved
water vapor winds and validate the key enabling technologies leading to an operational instrument. An advanced geostationary satellite sounding measurement capability will lead to improved weather and climate analysis and prediction. The improved soundings and other unique scientific products (e.g., the vertical distribution of water vapor flux), to be derived from an operational implementation of GIFTS, will enhance atmospheric research and operational meteorology on a routine and long-term basis

## Considerations for Flexible Circuit Layout

1. Straight trace runs, within flexing areas, perpendicular to flexing axis is required.

2. Conductor traces need to be as large as practical to prevent delamination.

3. Rounding or curvatures wherever possible to prevent tearing and delamination. This includes component pads and traces. Mitring of traces is an acceptable alternative to curving them.

4. Copper reinforcement along holes and cutouts, including inside corners. All cutouts are to be curved; no square cuts.
   Part of this is to include "tear stops", which are copper edged holes placed at the ends of slits in the film. This stops the tearing action from continuing through the film.

5. Areas of circuitry having component mounting must be rigidized with substrate material. This includes connectors at the end of flex cables. Only cable runs or parallel conductor traces may be truly flexible.

6. Vias were made larger than typical for rigid boards for the GIFTS flexible circuit. This was to compensate for the film movement and registration of circuit layers. It also helped with the implementation of mechanical punching of via holes, which was performed here at Langley. Mechanical punching was required due to delays in the installation of ETB's plasma etcher.

GIFTS Multi-layer Flex Circuit Evaluation

**Test Plan for Flex Circuit**
Version: 1
Author: Peter Huynh

- Microcontroller generates a ramp by using the onboard D/A .
- During the ramp, the microcontroller accesses the A/D to read in the voltage outputted by the D/A
- Compare the results by outputting the results to the PC via serial RS232

Flex Circuit Demo Setup Procedure
Version: 0.1

1) Connect J5 cable to the Flex Circuit (bottom right hand side connector) and the power supply
   - Connect J5 cable to the power supply as follow

| | | |
|---|---|---|
| Blue (4) | attach to | -12 V |
| Green (2) | attach to | GND |
| Black (5) | attach to | GND |
| Red (6) | attach to | + 12 V |
| Yellow (1) | attach to | + 5 V |

2) Connect RS-232 cable to a PC and the Flex Circuit (top right hand side connector)

3) Run the Hyper Terminal program

4) Setup the Hyper Terminal program (default setting is 9600 baud com port 2)

   Go to File → Properties;
   Select serial port in the "Connect using"
   Click on "Configure" to select the baud rate

   - Bits per second = 9600
   - Data bits = 8
   - Parity = None
   - Stop bits = 1

5) Power up the circuit and follow the instructions on the computer monitor to execute the program

RESULTS: The micro-controller generates a ramp voltage through the DAC output. The DAC output is then feed back through an ADC. The micro-controller then reads the AD channel. Hyper Terminal software then displays both the voltages so a comparison of signal loss can be made. In these experiments no difference is signal values were observed.

GIFTS Multi-layer Flex Circuit Parts List

| Item | Quantity | Part | |
|---|---|---|---|
| 1 | 18 | 0.1uF | (capacitor) |
| 2 | 5 | 47uF | |
| 3 | 2 | 10uF | |
| 4 | 2 | 33pF | |
| 5 | 14 | SD103CW | (diode) |
| 6 | 2 | DF3-8P-2H | (connector) |
| 7 | 2 | DF3-15P-2H(20) | |
| 8 | 2 | DF3-6P-2H | |
| 9 | 1 | Y7103CT | (resistor) |
| 10 | 1 | 1K | |
| 11 | 2 | 10K | |
| 12 | 1 | 6.04K | |
| 13 | 2 | 22K | |
| 14 | 1 | 8.25K | |
| 15 | 1 | 10 | |
| 16 | 1 | MAX180BCQH | (IC data acquisition system 44PL) |
| 17 | 1 | DM74LS373N | (IC tristate octal D FF SO-20) |
| 18 | 1 | 8751 | (IC microcontroller) |
| 19 | 1 | MAX508BCWP | (IC 12 bit DAC V output SO-20) |
| 20 | 1 | 74AC109SC | (IC dual JK flip-flop SO-16) |
| 21 | 1 | MAX242CWN | (IC 5V dual RS232 DVR/REC SO-18) |
| 22 | 1 | SE2506CT | (high-freq SMD 11.0592 MHz) |